



# Survival of root canal-treated teeth with fiber-reinforced post-restoration

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**Purpose:** The purpose of this retrospective study was to assess the survival rates of root canal treated teeth restored with fiber-reinforced post (FRP) restorations, considering characteristics such as post length, tooth type, and position and restoration type.

**Methods:** Data from 441 patients who received FRP restorations at the Akdeniz University, Faculty of Dentistry between 2018 and 2023 were analyzed. A total of 516 FRPs were examined, with post length-to-root length ratios used to categorize posts as either “long” ( $\geq 50\%$ ) or “short” ( $< 50\%$ ). Survival rates were assessed using the Kaplan-Meier method, with the log-rank test employed to identify significant differences between subgroups.

**Results:** The overall failure rate was 10.65%, with periapical inflammation being the most common cause. The Kaplan-Meier survival estimates at 12-, 36-, and 60-month were 98.2%, 87.5%, and 73%, respectively. Posts classified as “long” exhibited significantly higher survival rates than “short” posts ( $p = 0.04$ ). Anterior and premolars showed greater survival probabilities compared to molars ( $P < 0.001$ ).

**Conclusion:** The study found that post length and tooth type significantly influence the survival of FRP restorations. Longer posts and those placed in anterior and premolar teeth were associated with better outcomes. These findings highlight the importance of considering post length and tooth type in clinical decision-making, although further prospective studies with standardized protocols are necessary to validate these results.

**Keywords:** Post-restoration; root canal treatment; survival.

## Introduction

Post-core restorations provide stability and higher retention while supporting the coronal restoration after root canal treatment (RCT) for endodontically treated teeth with extensive enamel and dentin loss. Various treatments and materials have been offered for restoring a root canal-treated tooth (1,2).

The custom-made cast post-core restoration, introduced

in 1930, is widely regarded as one of the best treatment options for extensively damaged teeth due to its excellent physical properties and superior resistance to occlusal stresses. However, due to the high modulus of elasticity, it has been observed that fractures may occur in the root to which the post is applied (2,3). Due to the aesthetic expectations and advanced physical properties that have recently come to the fore, various post systems have been produced and used. Methacrylate resin posts, carbon

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fiber-reinforced posts (FRPs), quartz posts, glass FRPs, epoxy zirconia posts, and polyethylene FRPs have been listed among the systems used in recent years (4,5). FRPs have been recognized for their superior aesthetic outcomes and enhanced mechanical properties compared to cast and prefabricated posts. The modulus of elasticity of these posts, which closely approximates that of dentin, has been documented to mitigate the risk of root fractures and to decrease the incidence of irreparable failures. As a result, FRPs continue to be highly favored in clinical practice (2,6-8).

In their systematic review and meta-analysis, Wang et al. (9) found that FRPs used to restore endodontically treated teeth with no more than two coronal walls remaining demonstrated higher overall survival rates in the medium term (3 to 7 years) compared to metal posts. Similarly, Tsintsadze et al. (2) reported an overall survival rate of 92.8% for FRPs, compared to 78.1% for metal posts. There is no study in the literature evaluating the survival rate of FRPs based on variables such as tooth type (subgroups: anterior/premolar/posterior teeth), jaw location (subgroups: upper/lower jaw), type of restoration type (subgroups: crown/bridge/composite restoration), post length (subgroups: short/long FRP).

This study evaluated the survival rate of root canal treated teeth restored with FRPs applied to Akdeniz University, Faculty of Dentistry, Department of Endodontics clinic. The null hypothesis states that there is no difference in the survival rate of FRPs among the sub-groups based on the type of upper restoration, jaw location, type of tooth, and post-length/root length ratio.

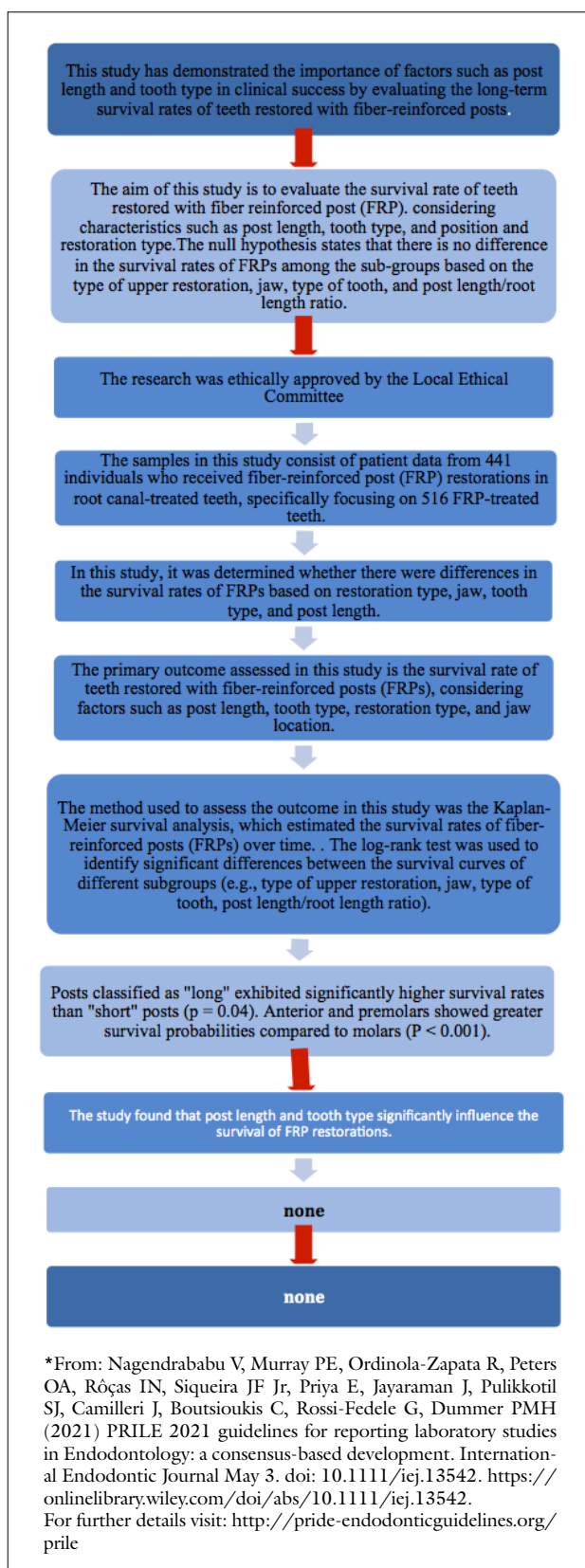
## Materials and Methods

The manuscript of this laboratory study has been written according to the Preferred Reporting Items for Laboratory Studies in Endodontology (PRILE) 2021 guidelines (10) (Fig. 1).

The research was ethically approved by the Ethical Committee of Akdeniz University, Türkiye (TBAEK-279, Date: 25/04/2024). The study was conducted under the principles of the Declaration of Helsinki.

Data were acquired from the patient records of individuals registered with Akdeniz University Faculty of Dentistry. Patients who applied to the Department of Endodontics at the Faculty of Dentistry for RCT and FRP procedures between 2018 and 2023 and were over the age of 18 were included in the study.

Exclusion criteria included patients under 18 years, cases where teeth were not clearly visible in radiographs (especially in the anterior region), patients lacking follow-up ra-



**Fig. 1.** PRILE 2021 flowchart: A visual representation of the study design.

diographs and with severe systemic diseases, patients with parafunctional habits in their medical history, and teeth that underwent FRPs application but were extracted for various reasons. These teeth were excluded to avoid confounding the survival assessment.

The data were obtained from the patient files of 1995 patients treated with FRPs and cores. Out of these, 441 patient files containing a total of 516 FRPs and cores fulfilled the inclusion criteria and were analyzed. Only FRP cases cemented with resin cement were included in the study. The data were obtained from the panoramic radiographs of the patients. Demographic data (age, gender) of the included patients and the following clinical details were recorded: Observation period (configuration date/last observation date), presence or absence of the post, tooth type (subgroups: Anterior/premolar/molar), upper restoration type (subgroups: Crown/bridge/composite restoration), post length/root length ratio (FRPs were classified as long if the ratio of post length to root length was 50% or more, and as short if it was less than 50%), and jaw location (upper/lower jaw). The periapical status was also recorded.

Survival data from post-and-core restorations were categorized based on several variables: Tooth type (subgroups: anterior/premolar/posterior teeth), type of restoration (subgroups: Crown/bridge/composite restoration), jaw location (subgroups: Lower/upper jaw), and post-length/root length ratio (subgroups: Short/long FRP). These data were presented as survival functions and analyzed using the Kaplan-Meier method.

FRPs that remained in place at the final examination without any adjustments were classified as “censored cases” (success). All other cases, such as post-debonding, post-fracture, vertical or horizontal root fracture, and periapical

lesions requiring endodontic retreatment were classified as “failures” even if the post and core were re-cemented. The log-rank test ( $P = 0.05$ ) was used to identify significant differences between two or more survival curves of the subgroups of the variables (e.g., anterior, premolar, posterior).

## Results

The study analyzed data from 441 patients, with 149 (34%) males and 292 (66%) females (Table 1), with an average age of 45.98 years (range: 18 to 85 years). The mean observation period for FRPs was 26.13 months. Table 2 and Table 3 provide the distribution of FRPs by type of tooth and their location, as well as by the type of tooth and restoration, respectively, including the number and percentage. At the final examination, 55 cases were recorded as failures, resulting in a total failure rate of 10.65%. The most common type of failure in this study was periapical inflammation, which was reported in 35 cases, accounting for 63.6% of failures. The Kaplan-Meier overall mean estimated survival probability at 12-, 36- and 60-month were 98.2%, 87.5%, and 73% respectively.

In Figure 2 and Figure 3, the Kaplan-Meier survival probability curves of the FRPs are shown in relation to the restoration type and jaw treated, respectively. Different restoration types (log-rank test,  $P = 0.96$ ) or jaw location (log-rank test,  $P = 0.85$ ) had no significant influence on survival time. However, a statistically significant difference was found in the survival time with respect to the fiber post-length/root length ratio (Fig. 4, log-rank test,  $P = 0.04$ ) and between different tooth types (Fig. 5, log-rank test,  $P < 0.001$ ). The survival probability was the highest in FRPs placed in the anterior and premolar teeth and in long posts.

**Table 1.** Distribution of FRPs by gender and jaw location

| Gender | n        | FRPs       | Lower jaw | Upper jaw |
|--------|----------|------------|-----------|-----------|
| Female | 292/66%  | 308/59.7%  | 100/54.7% | 208/62.4% |
| Male   | 149/34%  | 208/40.3 % | 83/45.3%  | 125/37.6% |
| Total  | 441/100% | 516/100%   | 183/100%  | 333/100%  |

FRP: Fiber-reinforced post.

**Table 2.** Distribution of FRPs by type of tooth and jaw location (number/percentage)

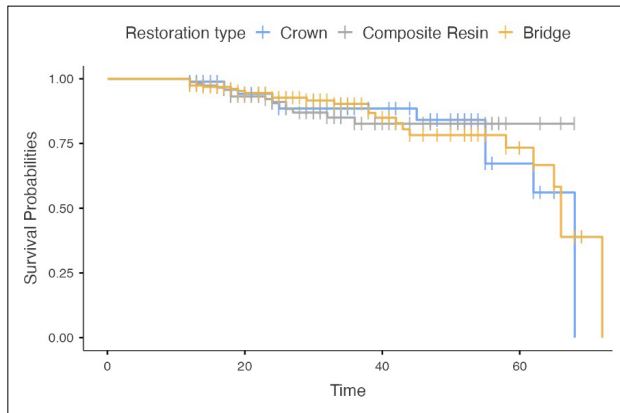
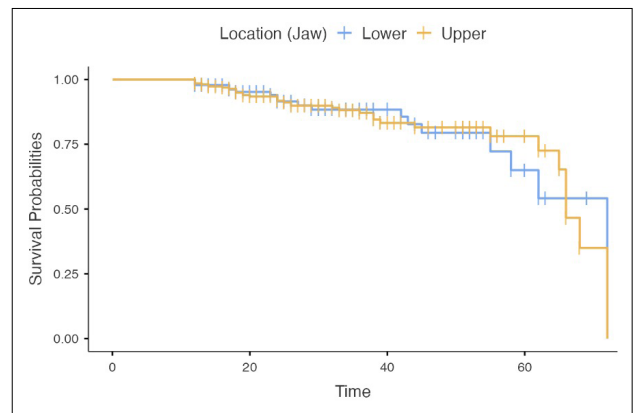
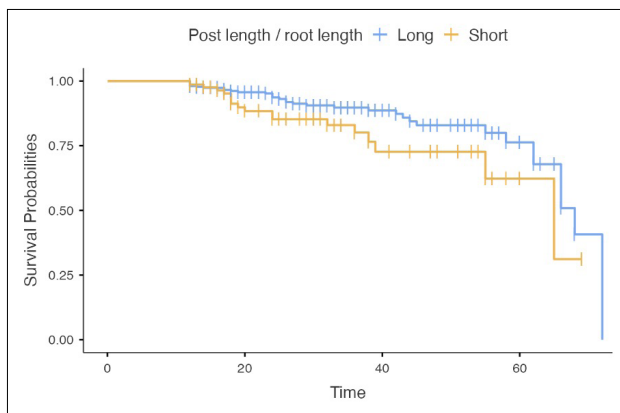
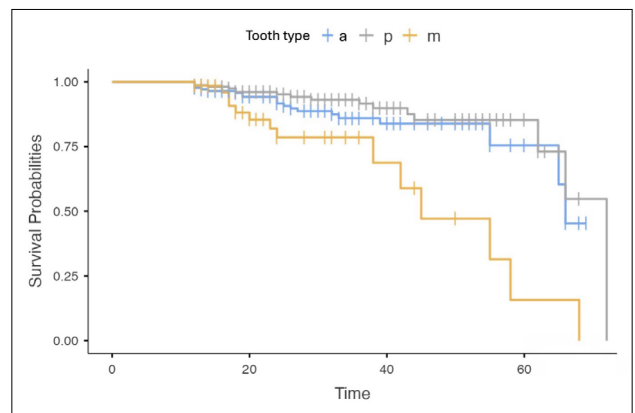
| Type of tooth | Upper jaw | Lower jaw | Total     |
|---------------|-----------|-----------|-----------|
| Anterior      | 186/36%   | 32/6.2%   | 218/42.2% |
| Premolar      | 126/24.4% | 105/20.3% | 231/44.8% |
| Molar         | 21/4.1%   | 46/9%     | 67/13%    |
| Total         | 333/64.5% | 183/35.5% | 516/100%  |

FRP: Fiber-reinforced post.

**Table 3.** Distribution of FRPs by type of tooth and restoration (number/percentage)

| Type of tooth | Crown    | Bridge    | Composite resin | Total |
|---------------|----------|-----------|-----------------|-------|
| Anterior      | 24/26.4% | 107/54.6% | 87/38%          | 218   |
| Premolar      | 52/57.1% | 73/37.2%  | 106/46.2%       | 231   |
| Molar         | 15/16.5% | 16/8.2%   | 36/15.8%        | 67    |
| Total         | 91       | 196       | 229             | 516   |

FRP: Fiber-reinforced post.

**Fig. 2.** Survival probability curve of teeth restored with FRP according to the restoration type. Differences among curves were not statistically significant (log-rank test,  $P = 0.96$ ).**Fig. 3.** Survival probability curve of teeth restored with FRP according to the jaw treated. Differences among curves were not statistically significant (log-rank test,  $P = 0.85$ ).**Fig. 4.** Survival probability curve of teeth restored with FRP according to the fiber post-length/root length ratio teeth. Differences among curves were statistically significant (log-rank test,  $P = 0.04$ ).**Fig. 5.** Survival probability curve of teeth restored with FRP according to the different tooth types. Differences among curves were statistically significant (log-rank test,  $P = 0.001$ ).

## Discussion

The patient data included in the study were obtained from a computer-assisted system in which patient records were digitally stored. This approach simplifies data collection and minimizes human errors. Prosthetic restorations following post-insertion included single crowns, bridges, and composite resins. The data indicated that neither the type

of restoration (subgroups: Single crown/ bridge/ composite resin) nor the jaw location (subgroups: Upper / lower jaw) significantly affected the survival probability of the FRP. However, statistically significant differences were observed among subgroups related to tooth type or post length. The Kaplan-Meier curves showed a significantly decreasing survival probability from premolar and anterior to molar and, from long to short fiber post. Therefore,

the null hypothesis, stating that there is no difference in the survival rates of FRPs among subgroups, should be partially accepted. Soares et al. (11) described in their review of the relevant literature a decrease in the survival rate from 5 to 18-year follow-up. Consistent with this study, the Kaplan-Meier overall mean estimated survival probabilities at 12-, 36-, and 60-month were 98.2%, 87.5%, and 73%, respectively.

Vogler et al.'s (12) retrospective study with a 16-year follow-up evaluated the effects of various factors on the survival probability of root canal treated teeth with fiber posts. These factors included the type of covering, prosthetic restoration, jaw location (upper or lower), tooth type, luting material, post and core material, bone attachment, and the therapist. This study found that the type of prosthetic restoration, tooth type, jaw location (upper or lower), post and core material, and bone attachment significantly affected the survival time of these teeth. Contrary to this study, the current study found that the jaw location (upper or lower) and restoration type did not have a significant effect on the probability of survival. A possible reason for this may be the smaller number of patients/ fiber-reinforced posts and the follow-up periods included in the study.

However, in the current study, the anterior and premolars were found to have significantly higher survival probabilities than the molars. The reason for the lower survival probability in molar teeth might be differences in the occlusal load of molar versus anterior/premolars.

The prognosis for root canal-treated teeth restored with FRPs is influenced by several factors, which have been studied either individually or in combination through in vitro experiments and clinical reports. These factors include the post material and design, post length and diameter, core build-up material, luting cement, adhesive system, ferrule height and amount of remaining coronal tooth structure (13- 17)

In this study, fiber-reinforced posts were classified as 'long' if the ratio of post length to root length was 50% or more, and as 'short' if it was less than 50%. The log-rank test revealed significant differences in survival between short and long fiber posts.

Braga et al. (18) found that 10 mm long fiber posts demonstrated greater resistance to removal compared to 6 mm posts. Additionally, Giovani et al. (19) showed that roots restored with longer fiber posts (10 mm) had greater resistance to fracture than those with 6 mm long posts. These findings support the significant differences in survival rates observed in this study between posts of various lengths.

The mean observation period for fiber-reinforced posts

was 26.13 months in the present study. Marchionatti et al. (20) highlighted in their systematic review that there is a need for studies with follow-up periods exceeding 10-year to better understand the long-term survival rates of posts and cores. Only a limited number of studies have investigated the survival of posts and cores over a follow-up period of 10-year or more (21-24).

The variability in post-treatment protocols, preparation, and cementation materials, as well as the treatments being performed by different clinicians, are limitations of this retrospective study.

While panoramic radiographs are advantageous in offering a comprehensive view of the dental structures during the follow-up process, they also have limitations, such as lower resolution compared to periapical radiographs, which might hinder the detection of minor root fractures or other subtle changes. This limitation could potentially affect the reported survival rates. Consequently, prospective studies with more rigorously controlled parameters and more detailed imaging modalities could yield more valuable data. In addition, longer observation periods may enhance the outcomes of future studies.

## Conclusion

The study concluded that FRPs with a longer post length-to-root length ratio demonstrated significantly higher survival rates than shorter posts. Anterior and premolar teeth showed better survival probabilities than molars. However, further prospective studies with standardized treatment protocols and longer observation periods are required to confirm these findings.

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**Informed consent:** Written informed consent was obtained from patients who participated in this study.

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